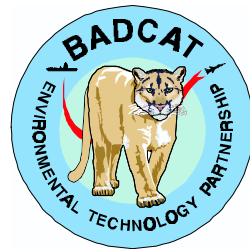




TechData Sheet

Naval Facilities Engineering Service Center
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Removal of Metals and Hydrocarbons from Contaminated Soils at Hunter s Point Shipyard

A Demonstration of the ChemTech Soil Treatment System

Conducted by:

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In cooperation with:

Bay Area Defense Conversion Action Team Environmental Technology Partnership

Introduction

Many military and industrial installations face the problem of cleaning up soils contaminated with heavy metals and hydrocarbons. Past remediation efforts have involved on-site stabilization or excavation and disposal of the soil in a secure landfill. With these remedies, the contaminants remain with the soil and therefore the potential for future long-term liability persists. Thermal desorption is one alternative for separating hydrocarbon contaminants from the soil. However, most heavy metals are not affected by conventional thermal desorption. Recently, soil washing technology has emerged as a potentially viable alternative for treatment of soils containing heavy metals, hydrocarbons, or both. Soil washing technology uses a variety of physical separation and chemical leaching techniques to separate the contaminants from the soil. Often, the treated soil can be returned to the site and the recovered contaminants can be separately disposed, treated, or recycled.

The Bay Area Defense Conversion Action Team (BADCAT) Environmental Technology Partnership (ETP) Project is a public-private partnership of the Bay Area Economic Forum, Bay Area Regional Technology Alliance, California Environmental Protection Agency, U. S. Environmental Protection Agency, U. S. Navy, Chevron Research and Technology Company, San Francisco State University Center for Public Environmental Oversight, and other technical experts working to expedite the cleanup and conversion of Bay Area closing bases through the application of new environmental technologies.

In mid-1996, BADCAT ETP approved a proposal by Klohn-Crippen Consultants Ltd. to conduct a pilot-scale demonstration of an innovative soil washing system patented by ChemTech Analysis, Inc. (see Figure 1). The demonstration was conducted on site at Hunter's Point Shipyard, San Francisco, California in January 1997. Soil containing heavy metals and hydrocarbons was treated by this technology. In addition, bench-scale treatability testing was conducted on a number of soil samples from the Bay Area.



Figure 1. The Soil Washing Pilot Plant Demonstrated at Hunter s Point

Purpose of Demonstration

The purpose of the pilot-scale demonstration was to determine if the ChemTech soil treatment process could be used to remove metals from soil to meet regulatory or risk-based levels and to estimate the costs of doing so at a commercial scale. A supplemental objective was to evaluate the applicability of the ChemTech process on a variety of Bay Area soils through bench-scale treatability testing.

Advantages of the ChemTech Soil Treatment Process

- ❑ Potential to remove heavy metals and hydrocarbons from soil to meet regulatory or risk-based criteria.
- ❑ Restoration of site for a broad range of beneficial uses because contaminants are removed from the soil.
- ❑ Potential for significant volume reduction of contamination, which reduces the potential for future liability.
- ❑ Potential to recover separated heavy metals for recycling at an off-site facility.
- ❑ Relatively low projected cleanup costs at larger sites for meeting RCRA-driven criteria for leachable (Toxicity Characteristic Leaching Procedure [TCLP]) metals, and industrial criteria for total metals and total petroleum hydrocarbons.

Limitations of the ChemTech Soil Treatment Process

- ❑ Because a full-scale system is currently not available, site managers may be hesitant to consider this technology as a remedial option.
- ❑ Requires relatively complex equipment and specialized operator training compared to landfilling or stabilization.
- ❑ Relatively longer processing time to achieve the required contaminant-reagent contact compared to stabilization, especially when significant fine soil or fine particulate metals are present.
- ❑ Space is needed on site for stockpiling pre- and post-treatment soil and residuals.
- ❑ Additional processing and cost may be necessary in order to meet stringent state or residential criteria. Also, residuals may require additional treatment for disposal.

Applicability

The most suitable match between the ChemTech process and contaminated soil is under conditions where the soil is coarse and contaminated either by metals and light hydrocarbons or by heavy hydrocarbons.

Technical Description

The ChemTech soil treatment system is different from conventional soil washing in that it uses an innovative fluidized bed/classifier to supply physical scouring and rapid kinetics chemical leaching, aggressive chemical conditions, and tight process engineering to recycle all process air and process water. Figure 2 shows the unit operations of the ChemTech soil treatment system.

The ChemTech plant used at Hunter's Point in San Francisco consisted of physical separation and chemical leaching unit processes. The fluidized bed and classifier are the main separation/leaching elements of the system. The three-phase fluidized bed is an enclosed vessel that blasts air through a hot acid or hot alkaline slurry of soil. In the classifier, fine particles are separated from coarse settleable particles by pumping process solution in an upflow direction. The fine soil particles, which are expected to contain most of the adsorbed contamination, are carried upward by the flow. In both the fluidized bed and classifier, a physical scouring action separates fine and coarse particles, as well as promotes removal of surface contamination from the soil particles. The hot process solution in these unit operations contains appropriate chemicals that leach out the contaminants into solution. The process solution is heated to approximately 80°C. The near-boiling temperatures and surfactants are used for solubilization of petroleum hydrocarbons, and pH adjustment (with acid or base) is used for solubilization of heavy metals.

The wet treated (coarse) soil may be returned to the site after verification of contaminant reduction to acceptable levels. The fine soil is separated from the process solution by dewatering in a pressure filter. The nonleachable fine solids may be retreated or disposed of in a secured landfill. The process solution is treated by adding precipitants and flocculants and is then recycled back to the system. The nonleachable precipitate sludge is the residual stream that contains some of the contamination and may need to be disposed of in a secured landfill.

Hunter's Point Shipyard Demonstration

At Hunter's Point, the soil contained antimony, copper, chromium, lead, zinc, and hydrocarbons. The pilot plant (see Figure 3) was operated at 80°C, a pH of 1.0 (with 75:25 hydrochloric and sulfuric acid mixed fluid), and a solids residence time in the fluidized bed of less than 5 minutes. The pilot plant was capable of processing 0.5 to 1 ton/day of screened soil. Eleven test runs were completed during the 7-day plant operation, processing a total of 2 tons of soil.

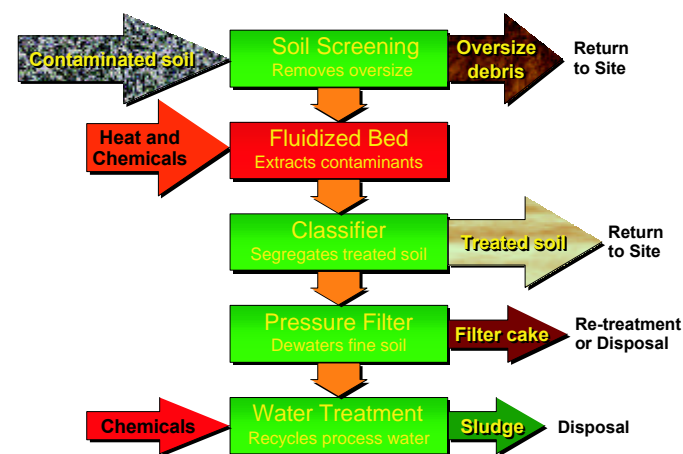


Figure 2. Soil Washing Unit Operations for Treating Heavy Metals and Hydrocarbons at Hunter's Point

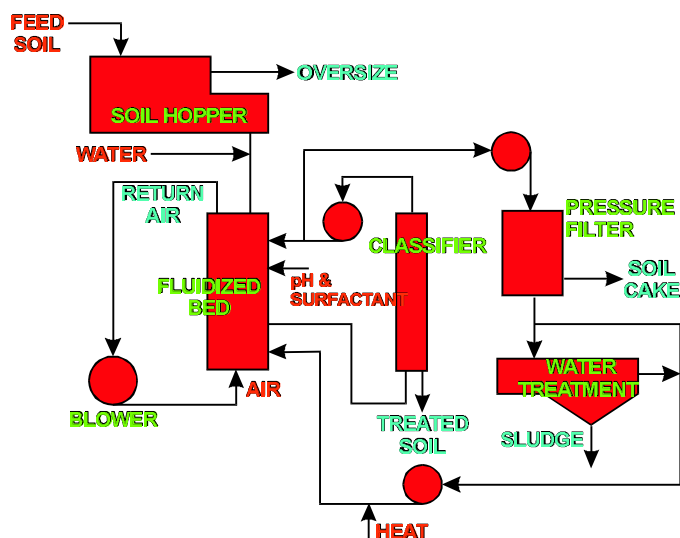


Figure 3. Pilot Plant Process Flow Diagram

Treatment Results

Table 1 shows the results of the pilot-scale treatment at Hunter's Point. Total metal concentrations were reduced for each of the five metals, up to 89% reduction for copper. Lead was reduced from above the industrial preliminary remediation goal (PRG) to below the PRG. Chromium was reduced from above the residential PRG to below the PRG. Leachable levels of chromium and zinc, as measured by the TCLP test, were reduced. Residential levels for lead and antimony were not obtained during the pilot test due to the presence of particulate metals from sources such as sand blasting grit, lead battery casings, and wire debris. Bench-scale testing showed that increasing the residence time to 15 minutes would help the soil meet residential criteria. Increasing the residence time would lower plant throughput and increase processing cost. Also, if relatively coarse

(greater than about 150 microns) metal particulates are present in the soil, the residence time required may be even longer. Alternatively, a variety of mining industry equipment would be needed to physically separate out particulate metals before leaching. This would add to the processing complexity and cost, but has been done successfully at some sites.

Total recoverable petroleum hydrocarbon (TRPH) levels in the untreated soil were relatively low (363 mg/kg), but were reduced further to 159 mg/kg by the hot acid conditions used in the pilot test. In bench-scale testing on an oily soil from Mare Island, alkaline treatment was able to reduce TRPH from 17,000 mg/kg to less than 2,000 mg/kg after 10 minutes of washing.

The mass percentage of total solids for the Hunter's Point demonstration is as follows: 41% oversize debris (greater than 0.5 inch), 47% treated soil from the 4-inch and 12-inch classifiers, and 12% residuals.

Residuals

The soil treatment process concentrates contaminants into three residual streams: the pressure filter soil cake, water treatment sludge, and processwater.

The characteristics of the solid residuals at Hunter's Point are shown in Table 2. Both the lime/metals water treatment sludge and the pressure filter soil cake had elevated levels of metals, but both met TCLP criteria and were disposed of in a secured landfill. Residual process water met all U.S. National Guidelines except for phenol. The phenol could be addressed by alum or activated carbon treatment.

Site Preparation Requirements

Most pilot plant equipment, except the pressure filter, was mounted on an 8-ft x 16-ft trailer. Utilities required for the pilot plant operation included 62 kW of power and 1 gpm of water. A bermed asphalt pad is generally required to house the plant and store the soil and residuals. The bermed asphalt pad acts as a secondary containment to handle inevitable spills and leaks that arise in this type of wet processing.

Table 1. ChemTech Soil Treatment System Performance

Description	Performance					
	Antimony	Copper	Chromium	Lead	Zinc	TRPH
Average Total Concentration of Contaminant (mg/kg)						
Untreated Soil ^(a)	87	2,270	267	2,407	2,773	363
Treated Soil ^(b)	84	256	122	789	768	159
Percent Removal	3	89	54	67	72	56
Contaminant Leachable Concentrations (mg/kg)						
Feed Soil TCLP	0.10	<0.02	3.7	<1	22	—
Treated Soil TCLP	<0.05	<0.01	0.21	<0.2	0.38	—
Average Percent Reduction	—	—	94	—	98	—
TCLP Target	—	—	5	5	—	—
US EPA Region 9 PRGs (mg/kg)						
Residential	31	2,800	210	400	4,100	—
Industrial	680	63,000	450	1,000	100,000	—
Comparison with PRGs						
Residential	No	Yes	Yes	No	Yes	—
Industrial	Yes	Yes	Yes	Yes	Yes	—

(a) Mean value of three pretreatment samples obtained during two optimized test runs at Hunter's Point.

(b) Mean value of eight posttreatment samples obtained during two optimized test runs at Hunter's Point.

TCLP = Toxicity Characteristic Leaching Procedure.

TRPH = Total recoverable petroleum hydrocarbons.

Table 2. Characteristics of Solid Residuals

Parameter	Total Metal Concentration (mg/kg)		Leachable Metal Concentration TCLP (mg/L)	
	Cal. Haz. Waste TTLC	Results	TCLP Targets	Results
Pressure Filter Soil Cake				
Antimony	500	89	—	—
Chromium	2,500	1,375	5.0	<0.02
Copper	2,500	4,310	—	0.05
Lead	1,000	3,125	5.0	1.95
Zinc	5,000	7,890	—	200
TRPH	—	85	—	—
Water Treatment Sludge				
Antimony	500	47	—	—
Chromium	2,500	972	5.0	0.08
Copper	2,500	2,190	—	0.74
Lead	1,000	1,080	5.0	0.65
Zinc	5,000	4,240	—	200
TRPH	—	<20	—	—

Note: Shaded areas denote TTLC exceedance.
TCLP = Toxicity Characteristic Leaching Procedure.
TTLC = Total Threshold Limit Concentration.
TRPH = Total Recoverable Petroleum Hydrocarbons.

In general, the ChemTech soil treatment process is a promising alternative to off-site landfilling or on-site stabilization and has the potential to provide significant benefits in terms of removing contaminants from the site and reducing both contaminant volume and potential for future liability.

Cost

The cost for cleanup by means of the ChemTech process depends on the cleanup objective, the soil type, the types and concentrations of contaminants, and how the contaminants associate with the soil. These factors dictate the operating conditions, process kinetics, quantity of residuals, and cleanup cost. Excavation costs also will vary, depending on the depth and volume of the contaminated soil.

Figure 4 illustrates cleanup costs projected by Kohn-Crippen Consultants using the ChemTech system for metal-contaminated soil. Costs are based on treatment of 15,000 tons of soil in 41 days at a 375-ton/day plant. Costs could be higher at smaller sites, and could vary based on the type and level of contamination.

Included in these costs are treatability testing and analysis, mobilization, soil treatment, posttreatment and disposal of residuals, and a report. Not included are the cost of ownership and indirect costs.

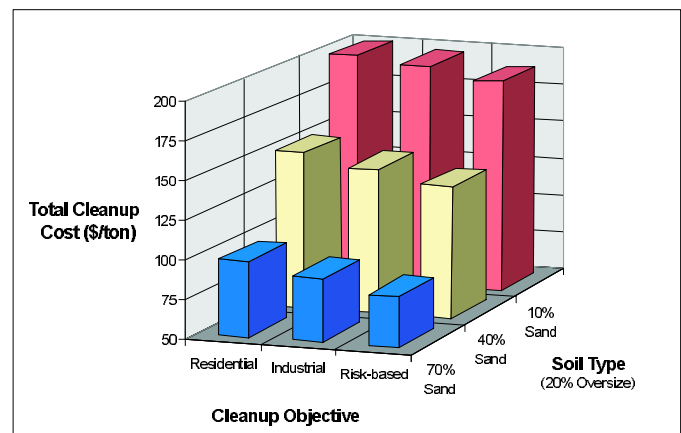


Figure 4. Projected Cleanup Costs for the ChemTech Soil Treatment System Based on Treatment of 15,000 Tons of Soil

For more information on **soil washing** or **BADCAT ETP**, contact:

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